



Memorandum

To: Sean Sheldrake, U.S. Environmental Protection Agency, Region 10

From: Eric Blischke
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Date: August 9, 2018

Subject: Review of Portland Harbor and River Mile 11 East Project Area PCB Volatilization from Surface Water

On June 13, 2018, concern over polychlorinated biphenyls (PCB) volatilization was raised during the EPA Community Leaders meeting. This topic was also a major topic of concern for the public and the Community Advisory Group technical advisor during review of the Portland Harbor proposed plan as documented in EPA's Responsiveness Summary in the January 2017 record of decision for the Portland Harbor Superfund Site (EPA 2017). The purpose of this memorandum is to perform a screening level evaluation of the potential for volatilization of PCBs from the Willamette River within the Portland Harbor Superfund Site to air under baseline conditions.

Approach

Data Selection

For this evaluation, the existing surface water data collected from 2004 to 2007 as part of the Portland Harbor remedial investigation were used to evaluate the risk to human health associated with volatilization of PCBs from surface water to air. The evaluation focused on volatilization of the dissolved PCB fraction only based on the assumption that particulate PCBs are not volatilizing to air. The evaluation was performed on a sitewide basis; a river mile transect basis at River Mile (RM) 2 and RM 11; and a sample location-specific basis, including within the River Mile 11 East (RM11E) Project Area. The RM11E Project Area was selected because PCBs are the predominant constituent of concern and were detected at elevated levels at this location and to support remedial design efforts related to community health and safety.

During the development of the Portland Harbor fate and transport model, PCBs were evaluated on a homolog-specific basis, focusing on tri- through hepta-chlorobiphenyl (PCB3 through PCB7) to account for differences in the physio-chemical fate and transport parameters associated with the degree of PCB chlorination. These five homolog groups, PCB3 through PCB7) were evaluated because they account for most of the PCB mass in the system (nearly 90%). To remain consistent with this approach for this evaluation, an average dissolved PCB surface water concentration for each of the five homolog groups was calculated and because each homolog group has different volatilization parameters, each homolog group was assumed to partition into a volume of air above

the surface of the Willamette River. The sum of the homolog groups was then used to develop a total PCB air concentration for comparison to generic screening criteria.

Screening Criteria

Regional Screening Levels (RSLs) are screening criteria that identify chemical concentrations in soil, tap water, and air below which EPA believes there is no concern under the Comprehensive Environmental Response, Compensation, and Liability Act, provided conditions associated with the screening criteria are met. RSLs are risk-based concentrations derived from standardized equations combining exposure information with EPA toxicity data using methods outlined in EPA Risk Assessment Guidance for Superfund Volume I Part B Manual (EPA 1991) and soil screening guidance documents (EPA 1996, 2002). RSLs are based on conservative default assumptions that represent reasonable maximum exposure conditions for long-term (chronic) exposures and are considered by EPA to be health protective for humans (including sensitive groups) over a lifetime. RSLs are chemical concentrations in soil, air, and water that correspond to fixed levels of risk (i.e., either one-in-one million [1×10^{-6}] cancer risk or a noncarcinogenic hazard index of 0.1). In most cases, where a chemical causes cancer and noncancer (systemic) effects, the 10^{-6} cancer risk results in a more health-protective criterion. These RSLs are based upon human health risk and do not address potential ecological concerns.

For this analysis, estimated air concentrations were screened against screening criteria based on residential land use. RSLs for residential-type land use are based on greater exposure frequency and duration and consider exposure to young children and thus are considered more conservative and health protective than RSLs for industrial land use. Industrial land use RSLs are also provided for comparison. Chemicals are screened against screening levels based on a cancer risk of 1×10^{-6} or a noncarcinogenic hazard quotient of 0.1. For chemicals with carcinogenic as well as noncarcinogenic effects, the lower RSL is used. For total PCBs, the air RSLs are:

- total PCB residential air screening level 4.9×10^{-3} micrograms per cubic meter ($\mu\text{g}/\text{m}^3$)
- total PCB industrial air screening level of $2.1 \times 10^{-2} \mu\text{g}/\text{m}^3$

RSLs for residential air assume that the resident spends most, if not all, of the day at home with typical home making chores (cooking, cleaning, and laundering) as well as outdoor activities while inhaling ambient air. It should be noted that the RSLs make no assumptions of how contaminants get into the air and the RSLs for air are intended to be compared to air samples, not air concentrations modeled from other media.

Volatilization Calculation

As stated in the final remedial investigation (EPA 2016), "Volatilization is the transfer of contaminants dissolved in surface water to the atmosphere and is most important for small organic molecules such as volatile organic compounds. It is dependent on water and air temperature, dissolved concentration, and vapor pressure. Water turbulence and wind velocity at the air/water interface will also affect volatilization rates. Volatilization typically decreases with increasing

molecular weight. Additionally, various forms of mercury and organolead compounds may also volatilize from the water column. Equilibrium partitioning between dissolved volatilized phases is defined by the Henry's law constant (H).¹ Although PCBs are also subject to photolysis in surface water, the process is considered minor for PCBs (EPA 1994) and thus not considered in this calculation.

For this technical memorandum, the partitioning of concentrations between surface water and air were evaluated using two methodologies: simple partitioning using chemical-specific Henry's law constants and a box model that considers factors such as diffusivity and wind speed.

Henry's Law Constant

The first methodology assumes the equilibrium condition represented by Henry's law constant:

$$K_H = C_g/C_l$$

Where:

K_H = Henry's constant law (dimensionless) [chemical-specific]

C_g = air concentration (milligrams per liter [mg/L])

C_l = water concentration (mg/L)

This relationship is intended for dilute solutions in pure water. In real aqueous solutions (where many chemical species are present), this relationship is approximate.

Box Model

For this analysis, a box model (Marti et al. 2014) was used, assuming the water is a flat surface in an outdoor scenario.

$$C_{aFE} = (q_{FE} \times L) / (u \times H)$$

$$\text{and } q = K_{overall} \times [1000C - (C_a/K_H)]$$

$$K_{overall} = 1 / [(1/K_L) + (1/(K_G \times K_H))]$$

$$K_L = (6.5E-06) \times [D_w / (1.488E-09)]^{0.67}$$

$$K_G = K_{G, H_2O} \times [D_a / (2.6E-05)]^{0.67}$$

Where:

C_{aFE} = air concentration (milligrams per cubic meter [mg/m³]) [calculated]

q_{FE} = flux of contaminant from a flat surface (milligrams per square meter per second [mg/m²-s]) [calculated]

C = bulk water concentration (mg/L) [site value]

C_a = bulk air concentration (mg/m³) [assumed that existing chemical concentrations in air over the river are orders of magnitude less than what transfers from the water; thus, this value is assumed to be zero (Bopp 1983)]

L = length of contaminated water in the direction of the wind (meters [m]) [assumed to be 0.5 mile = 804.672 m, consistent with the high frequency, low frequency, and tribal fisher direct contact exposure scenarios]

u = wind speed (meters per second [m/s]) [assumed to be 8 miles per hour¹= 3.58 m/s]

H = height of the box (m) [assumed to be 6 feet, which is the estimated breathing zone height =1.8288 m]

$K_{overall}$ = overall mass transfer coefficient (m/s) [calculated]

K_L = mass transfer coefficient for liquid (m/s) [calculated]

K_G = mass transfer coefficient for air (m/s) [calculated]

K_{G,H_2O} = mass transfer coefficient for air (water) [Marti et al. (2014) provides two values: 3.0×10^{-3} m/s for u=0 m/s; 8.5×10^{-3} m/s for u=2.25 m/s. Because the wind speed at the site is assumed to be 3.58 m/s, a linear relationship was assumed between these values, and the K_{G,H_2O} was calculated to be 1.2×10^{-2} m/s for u=3.58 m/s]

K_H = Henry's constant law (unitless) [chemical-specific]

D_a = diffusivity in air (m²/s) [chemical-specific]

D_w = diffusivity in water (m²/s) [chemical-specific]

Volatilization parameters for PCB homologs are summarized in **Table 1**.

¹ This is the average windspeed in Portland, Oregon from 2010 to present as reported on <https://wind.willyweather.com/or/multnomah-county/portland.html>.

Table 1 Volatilization Parameters for PCB Homologs

PCB Homolog	Henry's Law Constant ^a (HLS) (J/mol)	Henry's Law Constant ^b K _H (unitless)	Diffusivity in Water ^c D _w (m ² /s)	Diffusivity in Air ^c D _a (m ² /s)
PCB-tri	18.78	7.58E-03	5.80E-10	5.40E-06
PCB-tetra	15.03	6.06E-03	5.50E-10	5.20E-06
PCB-penta	8.36	3.37E-03	5.30E-10	5.00E-06
PCB-hexa	3.58	1.44E-03	5.10E-10	4.80E-06
PCB-hepta	1.54	6.23E-04	NA ^d	NA ^d

Notes:

NA = not available

J/mol = Joules per mole

m²/s = square meters per second

^a Brunner et al. (1990) [mean value among congeners within each homolog group]

^b Calculated using the following formula: K_H = HLS/(R × T); where R (Universal Gas Law Constant) = 8.314462 J/mole – K; and T (temperature) = 25 degrees Celsius, 298.15 degrees Kelvin

^c Bopp (1983) [25 degrees Celsius, 0%]

^d Since diffusivities were unavailable for PCB-hepta, the diffusivities for PCB-hexa were used for the calculations.

Modeled PCB Concentrations in Air

The calculated PCB concentrations in air for individual surface water sampling locations and on a sitewide basis are summarized in **Tables 2 and 3**.

Summing up the air concentrations of the PCB homologs by river mile (and by location for RM 2 and RM 11), the calculated air concentrations for all the river miles range from $2.8 \times 10^{-4} \mu\text{g}/\text{m}^3$ to $4.1 \times 10^{-3} \mu\text{g}/\text{m}^3$ by the Henry's law constant methodology and $1.9 \times 10^{-5} \mu\text{g}/\text{m}^3$ to $2.7 \times 10^{-4} \mu\text{g}/\text{m}^3$ by the box model methodology. Both calculated ranges are below the total PCB air screening levels of $4.9 \times 10^{-3} \mu\text{g}/\text{m}^3$ for residential and $2.1 \times 10^{-2} \mu\text{g}/\text{m}^3$ for industrial. As expected, the Henry's law constant methodology yields a more conservative (i.e., higher estimate) of air concentrations because it does not incorporate wind speed and the area over which the transfer occurs. The upper range of the estimated concentrations for the RM11E Project Area (from sample no. W023E) are $6.4 \times 10^{-4} \mu\text{g}/\text{m}^3$ by the Henry's law constant methodology and $4.2 \times 10^{-5} \mu\text{g}/\text{m}^3$ by the box model methodology; both concentrations are below the total PCB air screening residential and industrial levels.

The calculated air concentration from the sitewide average surface water concentration by the Henry's law constant methodology is lower than the calculated air concentrations for the individual river miles at $1.2 \times 10^{-3} \mu\text{g}/\text{m}^3$. For the box model methodology, the calculated air concentration from the sitewide average surface water concentration is higher than the calculated air concentrations for the individual river miles at $1.3 \times 10^{-3} \mu\text{g}/\text{m}^3$. Even though the sitewide average PCB concentration in surface water is lower, because the box model assumes that the same transfer rate occurs along the entire length of river (9 miles), the resulting estimated air concentration is higher.

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The results from both methodologies indicate that PCBs volatilizing from surface water to air are estimated to be at concentrations below health protective criteria both on a river mile and sitewide basis.

References

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Table 2 Modeled PCB Concentration in Air (Henry's Law Constant)

Location	Total PCB Homologs	Heptachlorobiphenyl homologs			Hexachlorobiphenyl homologs			Pentachlorobiphenyl homologs			Tetrachlorobiphenyl homologs			Trichlorobiphenyl homologs		
	C _a ($\mu\text{g}/\text{m}^3$)	C _w (pg/L)	H' (unitless)	C _a ($\mu\text{g}/\text{m}^3$)	C _w (pg/L)	H' (unitless)	C _a ($\mu\text{g}/\text{m}^3$)	C _w (pg/L)	H' (unitless)	C _a ($\mu\text{g}/\text{m}^3$)	C _w (pg/L)	H' (unitless)	C _a ($\mu\text{g}/\text{m}^3$)	C _w (pg/L)	H' (unitless)	C _a ($\mu\text{g}/\text{m}^3$)
2 (All)	1.32E-03	3.95	6.23E-04	2.46E-06	20.72	1.44E-03	2.99E-05	41.85	3.37E-03	1.41E-04	86.08	6.07E-03	5.22E-04	8.30E+01	7.58E-03	6.29E-04
2 (W025W)	9.12E-04	3.76	6.23E-04	2.34E-06	19.88	1.44E-03	2.87E-05	36.20	3.37E-03	1.22E-04	64.30	6.07E-03	3.90E-04	4.87E+01	7.58E-03	3.69E-04
2 (W025M)	8.29E-04	2.78	6.23E-04	1.73E-06	16.25	1.44E-03	2.35E-05	31.38	3.37E-03	1.06E-04	57.40	6.07E-03	3.48E-04	4.61E+01	7.58E-03	3.50E-04
2 (W025E)	2.40E-03	5.72	6.23E-04	3.56E-06	27.51	1.44E-03	3.97E-05	61.47	3.37E-03	2.07E-04	146.10	6.07E-03	8.86E-04	1.66E+02	7.58E-03	1.26E-03
2.1	1.97E-03	4.70	6.23E-04	2.93E-06	23.98	1.44E-03	3.46E-05	47.60	3.37E-03	1.61E-04	111.35	6.07E-03	6.75E-04	1.44E+02	7.58E-03	1.09E-03
2.9	9.70E-04	7.25	6.23E-04	4.52E-06	27.13	1.44E-03	3.92E-05	37.53	3.37E-03	1.27E-04	61.28	6.07E-03	3.72E-04	5.65E+01	7.58E-03	4.28E-04
3.6	1.72E-03	9.73	6.23E-04	6.06E-06	30.10	1.44E-03	4.35E-05	48.35	3.37E-03	1.63E-04	93.45	6.07E-03	5.67E-04	1.24E+02	7.58E-03	9.44E-04
3.9	9.83E-04	5.47	6.23E-04	3.40E-06	23.30	1.44E-03	3.37E-05	39.07	3.37E-03	1.32E-04	64.28	6.07E-03	3.90E-04	5.59E+01	7.58E-03	4.24E-04
4.4	5.36E-04	2.05	6.23E-04	1.28E-06	14.83	1.44E-03	2.14E-05	23.73	3.37E-03	8.00E-05	36.53	6.07E-03	2.22E-04	2.79E+01	7.58E-03	2.12E-04
5.5	5.75E-04	6.83	6.23E-04	4.25E-06	19.70	1.44E-03	2.85E-05	24.35	3.37E-03	8.21E-05	38.70	6.07E-03	2.35E-04	2.97E+01	7.58E-03	2.25E-04
6.1	5.66E-04	3.15	6.23E-04	1.96E-06	13.88	1.44E-03	2.00E-05	26.43	3.37E-03	8.91E-05	38.83	6.07E-03	2.35E-04	2.89E+01	7.58E-03	2.19E-04
6.3	9.03E-04	6.49	6.23E-04	4.04E-06	26.73	1.44E-03	3.86E-05	40.38	3.37E-03	1.36E-04	60.34	6.07E-03	3.66E-04	4.72E+01	7.58E-03	3.58E-04
6.7	4.07E-03	47.46	6.23E-04	2.96E-05	140.41	1.44E-03	2.03E-04	142.46	3.37E-03	4.81E-04	239.45	6.07E-03	1.45E-03	2.51E+02	7.58E-03	1.90E-03
6.9	2.06E-03	9.64	6.23E-04	6.01E-06	33.43	1.44E-03	4.83E-05	54.83	3.37E-03	1.85E-04	124.93	6.07E-03	7.58E-04	1.40E+02	7.58E-03	1.06E-03
7	6.10E-04	3.42	6.23E-04	2.13E-06	17.16	1.44E-03	2.48E-05	27.60	3.37E-03	9.31E-05	40.68	6.07E-03	2.47E-04	3.20E+01	7.58E-03	2.43E-04
7.2	1.53E-03	6.84	6.23E-04	4.26E-06	23.20	1.44E-03	3.35E-05	54.33	3.37E-03	1.83E-04	130.17	6.07E-03	7.90E-04	6.91E+01	7.58E-03	5.24E-04
7.5	4.81E-04	2.95	6.23E-04	1.83E-06	13.60	1.44E-03	1.96E-05	23.90	3.37E-03	8.06E-05	31.83	6.07E-03	1.93E-04	2.45E+01	7.58E-03	1.86E-04
8.3	1.53E-03	18.73	6.23E-04	1.17E-05	79.97	1.44E-03	1.15E-04	121.20	3.37E-03	4.09E-04	108.33	6.07E-03	6.57E-04	4.43E+01	7.58E-03	3.36E-04
8.5	9.52E-04	11.79	6.23E-04	7.34E-06	52.53	1.44E-03	7.59E-05	66.68	3.37E-03	2.25E-04	69.90	6.07E-03	4.24E-04	2.90E+01	7.58E-03	2.19E-04
8.6	5.59E-04	6.99	6.23E-04	4.35E-06	20.15	1.44E-03	2.91E-05	27.33	3.37E-03	9.22E-05	34.33	6.07E-03	2.08E-04	2.98E+01	7.58E-03	2.26E-04
9.6	5.54E-04	7.61	6.23E-04	4.74E-06	27.33	1.44E-03	3.95E-05	25.78	3.37E-03	8.69E-05	33.53	6.07E-03	2.03E-04	2.89E+01	7.58E-03	2.19E-04
9.9	3.22E-04	1.11	6.23E-04	6.91E-07	8.11	1.44E-03	1.17E-05	17.00	3.37E-03	5.73E-05	21.88	6.07E-03	1.33E-04	1.58E+01	7.58E-03	1.20E-04
10.9	2.80E-04	1.47	6.23E-04	9.17E-07	8.39	1.44E-03	1.21E-05	15.90	3.37E-03	5.36E-05	20.28	6.07E-03	1.23E-04	1.19E+01	7.58E-03	9.00E-05
11 (All)	4.97E-04	2.85	6.23E-04	1.78E-06	13.40	1.44E-03	1.94E-05	24.23	3.37E-03	8.17E-05	33.01	6.07E-03	2.00E-04	2.56E+01	7.58E-03	1.94E-04
11 (W023W)	4.52E-04	2.56	6.23E-04	1.60E-06	12.60	1.44E-03	1.82E-05	23.90	3.37E-03	8.06E-05	31.23	6.07E-03	1.89E-04	2.14E+01	7.58E-03	1.62E-04
11 (W023)	4.21E-04	2.71	6.23E-04	1.69E-06	10.94	1.44E-03	1.58E-05	22.44	3.37E-03	7.57E-05	28.80	6.07E-03	1.75E-04	2.02E+01	7.58E-03	1.53E-04
11 (W023E)	6.44E-04	3.33	6.23E-04	2.07E-06	17.48	1.44E-03	2.52E-05	26.93	3.37E-03	9.09E-05	40.40	6.07E-03	2.45E-04	3.71E+01	7.58E-03	2.81E-04
Sitewide	1.19E-03	9.29	6.23E-04	5.78E-06	33.55	1.44E-03	4.85E-05	46.57	3.37E-03	1.57E-04	75.40	6.07E-03	4.57E-04	6.89E+01	7.58E-03	5.22E-04

Residential Criteria ($\mu\text{g}/\text{m}^3$)

4.90E-03

Industrial Criteria ($\mu\text{g}/\text{m}^3$)

2.10E-02

Formulas

$$C_a = (C_w * H') / 1000000$$

C_a = Concentration in air ($\mu\text{g}/\text{m}^3$)

C_w = Concentration in water (pg/L)

H' = Henry's law constant (unitless)

$\mu\text{g}/\text{m}^3$ = micrograms per cubic meter

pg/L = picograms per liter

Table 3 Modeled PCB Concentration in Air (Box Model)

River Mile	Sum of C_{aFE} for all Homologs	River Mile Length L	Wind Speed u	Height H	Heptachlorobiphenyl homologs	Conc. in Air C_{aFE}	Flux of Contaminant from Flat Surface q_{FE}	Conc. in Water converted C_w	Overall Mass Transfer Coefficient $K_{overall}$	Mass Transfer Coefficient for liquid K_L	Mass Transfer Coefficient for gas K_G	Henry's Law Constant K_H	Diffusivity in Water D_w	Diffusivity in Air D_a
	($\mu\text{g}/\text{m}^3$)	(m)	(m/s)	(m)	pg/L	($\mu\text{g}/\text{m}^3$)	($\text{mg}/\text{m}^2\text{-s}$)	(mg/L)	(m/s)	(m/s)	(m/s)	(unitless)	(m^2/s)	(m^2/s)
2 (All)	8.20E-05	804.672	3.57632	1.8288	3.95E+00	6.58E-07	5.35E-12	3.95E-09	1.35E-06	3.17E-06	3.79E-03	6.23E-04	5.10E-10	4.80E-06
2 (W025W)	5.90E-05	804.672	3.57632	1.8288	3.76E+00	6.26E-07	5.09E-12	3.76E-09	1.35E-06	3.17E-06	3.79E-03	6.23E-04	5.10E-10	4.80E-06
2 (W025M)	5.29E-05	804.672	3.57632	1.8288	2.78E+00	4.63E-07	3.76E-12	2.78E-09	1.35E-06	3.17E-06	3.79E-03	6.23E-04	5.10E-10	4.80E-06
2 (W025E)	1.44E-04	804.672	3.57632	1.8288	5.72E+00	9.51E-07	7.73E-12	5.72E-09	1.35E-06	3.17E-06	3.79E-03	6.23E-04	5.10E-10	4.80E-06
2.1	1.17E-04	804.672	3.57632	1.8288	4.70E+00	7.82E-07	6.36E-12	4.70E-09	1.35E-06	3.17E-06	3.79E-03	6.23E-04	5.10E-10	4.80E-06
2.9	6.37E-05	804.672	3.57632	1.8288	7.25E+00	1.21E-06	9.81E-12	7.25E-09	1.35E-06	3.17E-06	3.79E-03	6.23E-04	5.10E-10	4.80E-06
3.6	1.06E-04	804.672	3.57632	1.8288	9.73E+00	1.62E-06	1.32E-11	9.73E-09	1.35E-06	3.17E-06	3.79E-03	6.23E-04	5.10E-10	4.80E-06
3.9	6.38E-05	804.672	3.57632	1.8288	5.47E+00	9.09E-07	7.39E-12	5.47E-09	1.35E-06	3.17E-06	3.79E-03	6.23E-04	5.10E-10	4.80E-06
4.4	3.55E-05	804.672	3.57632	1.8288	2.05E+00	3.41E-07	2.77E-12	2.05E-09	1.35E-06	3.17E-06	3.79E-03	6.23E-04	5.10E-10	4.80E-06
5.5	3.92E-05	804.672	3.57632	1.8288	6.83E+00	1.14E-06	9.23E-12	6.83E-09	1.35E-06	3.17E-06	3.79E-03	6.23E-04	5.10E-10	4.80E-06
6.1	3.75E-05	804.672	3.57632	1.8288	3.15E+00	5.24E-07	4.26E-12	3.15E-09	1.35E-06	3.17E-06	3.79E-03	6.23E-04	5.10E-10	4.80E-06
6.3	6.05E-05	804.672	3.57632	1.8288	6.49E+00	1.08E-06	8.77E-12	6.49E-09	1.35E-06	3.17E-06	3.79E-03	6.23E-04	5.10E-10	4.80E-06
6.7	2.71E-04	804.672	3.57632	1.8288	4.75E+01	7.90E-06	6.42E-11	4.75E-08	1.35E-06	3.17E-06	3.79E-03	6.23E-04	5.10E-10	4.80E-06
6.9	1.26E-04	804.672	3.57632	1.8288	9.64E+00	1.60E-06	1.30E-11	9.64E-09	1.35E-06	3.17E-06	3.79E-03	6.23E-04	5.10E-10	4.80E-06
7	4.06E-05	804.672	3.57632	1.8288	3.42E+00	5.69E-07	4.62E-12	3.42E-09	1.35E-06	3.17E-06	3.79E-03	6.23E-04	5.10E-10	4.80E-06
7.2	9.77E-05	804.672	3.57632	1.8288	6.84E+00	1.14E-06	9.25E-12	6.84E-09	1.35E-06	3.17E-06	3.79E-03	6.23E-04	5.10E-10	4.80E-06
7.5	3.24E-05	804.672	3.57632	1.8288	2.95E+00	4.90E-07	3.98E-12	2.95E-09	1.35E-06	3.17E-06	3.79E-03	6.23E-04	5.10E-10	4.80E-06
8.3	1.18E-04	804.672	3.57632	1.8288	1.87E+01	3.12E-06	2.53E-11	1.87E-08	1.35E-06	3.17E-06	3.79E-03	6.23E-04	5.10E-10	4.80E-06
8.5	7.26E-05	804.672	3.57632	1.8288	1.18E+01	1.96E-06	1.59E-11	1.18E-08	1.35E-06	3.17E-06	3.79E-03	6.23E-04	5.10E-10	4.80E-06
8.6	3.87E-05	804.672	3.57632	1.8288	6.99E+00	1.16E-06	9.45E-12	6.99E-09	1.35E-06	3.17E-06	3.79E-03	6.23E-04	5.10E-10	4.80E-06
9.6	3.94E-05	804.672	3.57632	1.8288	7.61E+00	1.27E-06	1.03E-11	7.61E-09	1.35E-06	3.17E-06	3.79E-03	6.23E-04	5.10E-10	4.80E-06
9.9	2.16E-05	804.672	3.57632	1.8288	1.11E+00	1.85E-07	1.50E-12	1.11E-09	1.35E-06	3.17E-06	3.79E-03	6.23E-04	5.10E-10	4.80E-06
10.9	1.93E-05	804.672	3.57632	1.8288	1.47E+00	2.45E-07	1.99E-12	1.47E-09	1.35E-06	3.17E-06	3.79E-03	6.23E-04	5.10E-10	4.80E-06
11 (All)	3.33E-05	804.672	3.57632	1.8288	2.85E+00	4.74E-07	3.86E-12	2.85E-09	1.35E-06	3.17E-06	3.79E-03	6.23E-04	5.10E-10	4.80E-06
11 (W023W)	3.07E-05	804.672	3.57632	1.8288	2.56E+00	4.27E-07	3.47E-12	2.56E-09	1.35E-06	3.17E-06	3.79E-03	6.23E-04	5.10E-10	4.80E-06
11 (W023)	2.85E-05	804.672	3.57632	1.8288	2.71E+00	4.51E-07	3.67E-12	2.71E-09	1.35E-06	3.17E-06	3.79E-03	6.23E-04	5.10E-10	4.80E-06
11 (W023E)	4.23E-05	804.672	3.57632	1.8288	3.33E+00	5.54E-07	4.50E-12	3.33E-09	1.35E-06	3.17E-06	3.79E-03	6.23E-04	5.10E-10	4.80E-06
Sitewide	1.34E-03	14484.1	3.57632	1.8288	9.29E+00	3.62E-05	1.64E-11	9.29E-09	1.76E-06	3.17E-06	2.74E-03	1.44E-03	5.10E-10	4.80E-06

Residential Criteria ($\mu\text{g}/\text{m}^3$)

4.90E-03

Industrial Criteria ($\mu\text{g}/\text{m}^3$)

2.10E-02

Formulas

$$C_{aFE} = (q_{FE} \times L) / (u \times H)$$

$$q = K_{overall} \times [1000C - (C_a/K_H)]$$

$$K_{overall} = 1 / [(1/K_L) + (1/(K_G \times K_H))]$$

$$K_L = (6.5E-06) \times [D_w / (1.488E-09)]^{0.67}$$

$$K_G = K_{G, H2O} \times [D_a / (2.6E-05)]^{0.67}$$

$$C_a/K_H \approx 0$$

$\mu\text{g}/\text{m}^3$ = micrograms per cubic meter

m = meter

m/s = meters per second

pg/L = picograms per liter

mg/L = milligrams per liter

mg/m²-s = milligrams per square meter-second

m^2/s = square meters per second

Table 3 Modeled PCB Concentration in Air (Box Model)

River Mile	Sum of C _{aFE} for all Homologs	River Mile Length L	Wind Speed u	Height H	Hexachlorobiphenyl homologs	Conc. in Air C _{aFE}	Flux of Contaminant from Flat Surface q _{FE}	Conc. in Water converted C _w	Overall Mass Transfer Coefficient K _{overall}	Mass Transfer Coefficient for liquid K _L	Mass Transfer Coefficient for gas K _G	Henry's Law Constant K _H	Diffusivity in Water D _w	Diffusivity in Air D _a
	($\mu\text{g}/\text{m}^3$)	(m)	(m/s)	(m)	pg/L	($\mu\text{g}/\text{m}^3$)	(mg/m ² -s)	(mg/L)	(m/s)	(m/s)	(m/s)	(unitless)	(m ² /s)	(m ² /s)
2 (All)	8.20E-05	804.672	3.57632	1.8288	2.07E+01	5.12E-06	4.16E-11	2.07E-08	2.01E-06	3.17E-06	3.79E-03	1.44E-03	5.10E-10	4.80E-06
2 (W025W)	5.90E-05	804.672	3.57632	1.8288	1.99E+01	4.91E-06	3.99E-11	1.99E-08	2.01E-06	3.17E-06	3.79E-03	1.44E-03	5.10E-10	4.80E-06
2 (W025M)	5.29E-05	804.672	3.57632	1.8288	1.63E+01	4.01E-06	3.26E-11	1.63E-08	2.01E-06	3.17E-06	3.79E-03	1.44E-03	5.10E-10	4.80E-06
2 (W025E)	1.44E-04	804.672	3.57632	1.8288	2.75E+01	6.80E-06	5.52E-11	2.75E-08	2.01E-06	3.17E-06	3.79E-03	1.44E-03	5.10E-10	4.80E-06
2.1	1.17E-04	804.672	3.57632	1.8288	2.40E+01	5.92E-06	4.81E-11	2.40E-08	2.01E-06	3.17E-06	3.79E-03	1.44E-03	5.10E-10	4.80E-06
2.9	6.37E-05	804.672	3.57632	1.8288	2.71E+01	6.70E-06	5.45E-11	2.71E-08	2.01E-06	3.17E-06	3.79E-03	1.44E-03	5.10E-10	4.80E-06
3.6	1.06E-04	804.672	3.57632	1.8288	3.01E+01	7.43E-06	6.04E-11	3.01E-08	2.01E-06	3.17E-06	3.79E-03	1.44E-03	5.10E-10	4.80E-06
3.9	6.38E-05	804.672	3.57632	1.8288	2.33E+01	5.75E-06	4.68E-11	2.33E-08	2.01E-06	3.17E-06	3.79E-03	1.44E-03	5.10E-10	4.80E-06
4.4	3.55E-05	804.672	3.57632	1.8288	1.48E+01	3.66E-06	2.98E-11	1.48E-08	2.01E-06	3.17E-06	3.79E-03	1.44E-03	5.10E-10	4.80E-06
5.5	3.92E-05	804.672	3.57632	1.8288	1.97E+01	4.87E-06	3.95E-11	1.97E-08	2.01E-06	3.17E-06	3.79E-03	1.44E-03	5.10E-10	4.80E-06
6.1	3.75E-05	804.672	3.57632	1.8288	1.39E+01	3.43E-06	2.79E-11	1.39E-08	2.01E-06	3.17E-06	3.79E-03	1.44E-03	5.10E-10	4.80E-06
6.3	6.05E-05	804.672	3.57632	1.8288	2.67E+01	6.60E-06	5.37E-11	2.67E-08	2.01E-06	3.17E-06	3.79E-03	1.44E-03	5.10E-10	4.80E-06
6.7	2.71E-04	804.672	3.57632	1.8288	1.40E+02	3.47E-05	2.82E-10	1.40E-07	2.01E-06	3.17E-06	3.79E-03	1.44E-03	5.10E-10	4.80E-06
6.9	1.26E-04	804.672	3.57632	1.8288	3.34E+01	8.26E-06	6.71E-11	3.34E-08	2.01E-06	3.17E-06	3.79E-03	1.44E-03	5.10E-10	4.80E-06
7	4.06E-05	804.672	3.57632	1.8288	1.72E+01	4.24E-06	3.44E-11	1.72E-08	2.01E-06	3.17E-06	3.79E-03	1.44E-03	5.10E-10	4.80E-06
7.2	9.77E-05	804.672	3.57632	1.8288	2.32E+01	5.73E-06	4.66E-11	2.32E-08	2.01E-06	3.17E-06	3.79E-03	1.44E-03	5.10E-10	4.80E-06
7.5	3.24E-05	804.672	3.57632	1.8288	1.36E+01	3.36E-06	2.73E-11	1.36E-08	2.01E-06	3.17E-06	3.79E-03	1.44E-03	5.10E-10	4.80E-06
8.3	1.18E-04	804.672	3.57632	1.8288	8.00E+01	1.97E-05	1.61E-10	8.00E-08	2.01E-06	3.17E-06	3.79E-03	1.44E-03	5.10E-10	4.80E-06
8.5	7.26E-05	804.672	3.57632	1.8288	5.25E+01	1.30E-05	1.05E-10	5.25E-08	2.01E-06	3.17E-06	3.79E-03	1.44E-03	5.10E-10	4.80E-06
8.6	3.87E-05	804.672	3.57632	1.8288	2.02E+01	4.98E-06	4.04E-11	2.02E-08	2.01E-06	3.17E-06	3.79E-03	1.44E-03	5.10E-10	4.80E-06
9.6	3.94E-05	804.672	3.57632	1.8288	2.73E+01	6.75E-06	5.49E-11	2.73E-08	2.01E-06	3.17E-06	3.79E-03	1.44E-03	5.10E-10	4.80E-06
9.9	2.16E-05	804.672	3.57632	1.8288	8.11E+00	2.00E-06	1.63E-11	8.11E-09	2.01E-06	3.17E-06	3.79E-03	1.44E-03	5.10E-10	4.80E-06
10.9	1.93E-05	804.672	3.57632	1.8288	8.39E+00	2.07E-06	1.68E-11	8.39E-09	2.01E-06	3.17E-06	3.79E-03	1.44E-03	5.10E-10	4.80E-06
11 (All)	3.33E-05	804.672	3.57632	1.8288	1.34E+01	3.31E-06	2.69E-11	1.34E-08	2.01E-06	3.17E-06	3.79E-03	1.44E-03	5.10E-10	4.80E-06
11 (W023W)	3.07E-05	804.672	3.57632	1.8288	1.26E+01	3.11E-06	2.53E-11	1.26E-08	2.01E-06	3.17E-06	3.79E-03	1.44E-03	5.10E-10	4.80E-06
11 (W023)	2.85E-05	804.672	3.57632	1.8288	1.09E+01	2.70E-06	2.20E-11	1.09E-08	2.01E-06	3.17E-06	3.79E-03	1.44E-03	5.10E-10	4.80E-06
11 (W023E)	4.23E-05	804.672	3.57632	1.8288	1.75E+01	4.32E-06	3.51E-11	1.75E-08	2.01E-06	3.17E-06	3.79E-03	1.44E-03	5.10E-10	4.80E-06
Sitewide	1.34E-03	14484.1	3.57632	1.8288	3.35E+01	1.31E-04	5.91E-11	3.35E-08	1.76E-06	3.17E-06	2.74E-03	1.44E-03	5.10E-10	4.80E-06

Residential Criteria ($\mu\text{g}/\text{m}^3$)

4.90E-03

Industrial Criteria ($\mu\text{g}/\text{m}^3$)

2.10E-02

Formulas

$$C_{aFE} = (q_{FE} \times L) / (u \times H)$$

$$q = K_{overall} \times [1000C - (C_a/K_H)]$$

$$K_{overall} = 1 / [(1/K_L) + (1/(K_G \times K_H))]$$

$$K_L = (6.5E-06) \times [D_w / (1.488E-09)]^{0.67}$$

$$K_G = K_{G, H2O} \times [D_a / (2.6E-05)]^{0.67}$$

$$C_a/K_H \approx 0$$

$\mu\text{g}/\text{m}^3$ = micrograms per cubic meter

m = meter

m/s = meters per second

pg/L = picograms per liter

mg/L = milligrams per liter

mg/m²-s = milligrams per square meter-second

m^2/s = square meters per second

Table 3 Modeled PCB Concentration in Air (Box Model)

River Mile	Sum of C_{aFE} for all Homologs	River Mile Length L	Wind Speed u	Height H	Pentachlorobiphenyl homologs	Conc. in Air C_{aFE}	Flux of Contaminant from Flat Surface q_{FE}	Conc. in Water converted C_w	Overall Mass Transfer Coefficient $K_{overall}$	Mass Transfer Coefficient for liquid K_L	Mass Transfer Coefficient for gas K_G	Henry's Law Constant K_H	Diffusivity in Water D_w	Diffusivity in Air D_a	
	($\mu\text{g}/\text{m}^3$)	(m)	(m/s)	(m)		($\mu\text{g}/\text{m}^3$)	($\text{mg}/\text{m}^2\cdot\text{s}$)	(mg/L)	(m/s)	(m/s)	(m/s)	(unitless)	(m^2/s)	(m^2/s)	
2 (All)	8.20E-05	804.672	3.57632	1.8288		4.19E+01	1.34E-05	1.09E-10	4.19E-08	2.61E-06	3.25E-06	3.89E-03	3.37E-03	5.30E-10	5.00E-06
2 (W025W)	5.90E-05	804.672	3.57632	1.8288		3.62E+01	1.16E-05	9.44E-11	3.62E-08	2.61E-06	3.25E-06	3.89E-03	3.37E-03	5.30E-10	5.00E-06
2 (W025M)	5.29E-05	804.672	3.57632	1.8288		3.14E+01	1.01E-05	8.18E-11	3.14E-08	2.61E-06	3.25E-06	3.89E-03	3.37E-03	5.30E-10	5.00E-06
2 (W025E)	1.44E-04	804.672	3.57632	1.8288		6.15E+01	1.97E-05	1.60E-10	6.15E-08	2.61E-06	3.25E-06	3.89E-03	3.37E-03	5.30E-10	5.00E-06
2.1	1.17E-04	804.672	3.57632	1.8288		4.76E+01	1.53E-05	1.24E-10	4.76E-08	2.61E-06	3.25E-06	3.89E-03	3.37E-03	5.30E-10	5.00E-06
2.9	6.37E-05	804.672	3.57632	1.8288		3.75E+01	1.20E-05	9.79E-11	3.75E-08	2.61E-06	3.25E-06	3.89E-03	3.37E-03	5.30E-10	5.00E-06
3.6	1.06E-04	804.672	3.57632	1.8288		4.84E+01	1.55E-05	1.26E-10	4.84E-08	2.61E-06	3.25E-06	3.89E-03	3.37E-03	5.30E-10	5.00E-06
3.9	6.38E-05	804.672	3.57632	1.8288		3.91E+01	1.25E-05	1.02E-10	3.91E-08	2.61E-06	3.25E-06	3.89E-03	3.37E-03	5.30E-10	5.00E-06
4.4	3.55E-05	804.672	3.57632	1.8288		2.37E+01	7.61E-06	6.19E-11	2.37E-08	2.61E-06	3.25E-06	3.89E-03	3.37E-03	5.30E-10	5.00E-06
5.5	3.92E-05	804.672	3.57632	1.8288		2.44E+01	7.81E-06	6.35E-11	2.44E-08	2.61E-06	3.25E-06	3.89E-03	3.37E-03	5.30E-10	5.00E-06
6.1	3.75E-05	804.672	3.57632	1.8288		2.64E+01	8.48E-06	6.89E-11	2.64E-08	2.61E-06	3.25E-06	3.89E-03	3.37E-03	5.30E-10	5.00E-06
6.3	6.05E-05	804.672	3.57632	1.8288		4.04E+01	1.30E-05	1.05E-10	4.04E-08	2.61E-06	3.25E-06	3.89E-03	3.37E-03	5.30E-10	5.00E-06
6.7	2.71E-04	804.672	3.57632	1.8288		1.42E+02	4.57E-05	3.72E-10	1.42E-07	2.61E-06	3.25E-06	3.89E-03	3.37E-03	5.30E-10	5.00E-06
6.9	1.26E-04	804.672	3.57632	1.8288		5.48E+01	1.76E-05	1.43E-10	5.48E-08	2.61E-06	3.25E-06	3.89E-03	3.37E-03	5.30E-10	5.00E-06
7	4.06E-05	804.672	3.57632	1.8288		2.76E+01	8.86E-06	7.20E-11	2.76E-08	2.61E-06	3.25E-06	3.89E-03	3.37E-03	5.30E-10	5.00E-06
7.2	9.77E-05	804.672	3.57632	1.8288		5.43E+01	1.74E-05	1.42E-10	5.43E-08	2.61E-06	3.25E-06	3.89E-03	3.37E-03	5.30E-10	5.00E-06
7.5	3.24E-05	804.672	3.57632	1.8288		2.39E+01	7.67E-06	6.23E-11	2.39E-08	2.61E-06	3.25E-06	3.89E-03	3.37E-03	5.30E-10	5.00E-06
8.3	1.18E-04	804.672	3.57632	1.8288		1.21E+02	3.89E-05	3.16E-10	1.21E-07	2.61E-06	3.25E-06	3.89E-03	3.37E-03	5.30E-10	5.00E-06
8.5	7.26E-05	804.672	3.57632	1.8288		6.67E+01	2.14E-05	1.74E-10	6.67E-08	2.61E-06	3.25E-06	3.89E-03	3.37E-03	5.30E-10	5.00E-06
8.6	3.87E-05	804.672	3.57632	1.8288		2.73E+01	8.77E-06	7.13E-11	2.73E-08	2.61E-06	3.25E-06	3.89E-03	3.37E-03	5.30E-10	5.00E-06
9.6	3.94E-05	804.672	3.57632	1.8288		2.58E+01	8.27E-06	6.72E-11	2.58E-08	2.61E-06	3.25E-06	3.89E-03	3.37E-03	5.30E-10	5.00E-06
9.9	2.16E-05	804.672	3.57632	1.8288		1.70E+01	5.45E-06	4.43E-11	1.70E-08	2.61E-06	3.25E-06	3.89E-03	3.37E-03	5.30E-10	5.00E-06
10.9	1.93E-05	804.672	3.57632	1.8288		1.59E+01	5.10E-06	4.15E-11	1.59E-08	2.61E-06	3.25E-06	3.89E-03	3.37E-03	5.30E-10	5.00E-06
11 (All)	3.33E-05	804.672	3.57632	1.8288		2.42E+01	7.77E-06	6.32E-11	2.42E-08	2.61E-06	3.25E-06	3.89E-03	3.37E-03	5.30E-10	5.00E-06
11 (W023W)	3.07E-05	804.672	3.57632	1.8288		2.39E+01	7.67E-06	6.23E-11	2.39E-08	2.61E-06	3.25E-06	3.89E-03	3.37E-03	5.30E-10	5.00E-06
11 (W023)	2.85E-05	804.672	3.57632	1.8288		2.24E+01	7.20E-06	5.85E-11	2.24E-08	2.61E-06	3.25E-06	3.89E-03	3.37E-03	5.30E-10	5.00E-06
11 (W023E)	4.23E-05	804.672	3.57632	1.8288		2.69E+01	8.64E-06	7.02E-11	2.69E-08	2.61E-06	3.25E-06	3.89E-03	3.37E-03	5.30E-10	5.00E-06
Sitewide	1.34E-03	14484.1	3.57632	1.8288		4.66E+01	2.50E-04	1.13E-10	4.66E-08	2.42E-06	3.25E-06	2.82E-03	3.37E-03	5.30E-10	5.00E-06

Residential Criteria ($\mu\text{g}/\text{m}^3$)

4.90E-03

Industrial Criteria ($\mu\text{g}/\text{m}^3$)

2.10E-02

Formulas

$$C_{aFE} = (q_{FE} \times L) / (u \times H)$$

$$q = K_{overall} \times [1000C - (C_a/K_H)]$$

$$K_{overall} = 1 / [(1/K_L) + (1/(K_G \times K_H))]$$

$$K_L = (6.5E-06) \times [D_w / (1.488E-09)]^{0.67}$$

$$K_G = K_{G,H2O} \times [D_a / (2.6E-05)]^{0.67}$$

$$C_a/K_H \approx 0$$

$\mu\text{g}/\text{m}^3$ = micrograms per cubic meter

m = meter

m/s = meters per second

pg/L = picograms per liter

mg/L = milligrams per liter

mg/m²-s = milligrams per square meter-second

m^2/s = square meters per second

Table 3 Modeled PCB Concentration in Air (Box Model)

River Mile	Sum of C_{aFE} for all Homologs	River Mile Length L	Wind Speed u	Height H	Tetrachlorobiphenyl homologs	Conc. in Air C_{aFE}	Flux of Contaminant from Flat Surface q_{FE}	Conc. in Water converted C_w	Overall Mass Transfer Coefficient $K_{overall}$	Mass Transfer Coefficient for liquid K_L	Mass Transfer Coefficient for gas K_G	Henry's Law Constant K_H	Diffusivity in Water D_w	Diffusivity in Air D_a	
	($\mu\text{g}/\text{m}^3$)	(m)	(m/s)	(m)		($\mu\text{g}/\text{m}^3$)	($\text{mg}/\text{m}^2\cdot\text{s}$)	(mg/L)	(m/s)	(m/s)	(m/s)	(unitless)	(m^2/s)	(m^2/s)	
2 (All)	8.20E-05	804.672	3.57632	1.8288		8.61E+01	3.11E-05	2.52E-10	8.61E-08	2.93E-06	3.34E-06	3.99E-03	6.07E-03	5.50E-10	5.20E-06
2 (W025W)	5.90E-05	804.672	3.57632	1.8288		6.43E+01	2.32E-05	1.89E-10	6.43E-08	2.93E-06	3.34E-06	3.99E-03	6.07E-03	5.50E-10	5.20E-06
2 (W025M)	5.29E-05	804.672	3.57632	1.8288		5.74E+01	2.07E-05	1.68E-10	5.74E-08	2.93E-06	3.34E-06	3.99E-03	6.07E-03	5.50E-10	5.20E-06
2 (W025E)	1.44E-04	804.672	3.57632	1.8288		1.46E+02	5.27E-05	4.28E-10	1.46E-07	2.93E-06	3.34E-06	3.99E-03	6.07E-03	5.50E-10	5.20E-06
2.1	1.17E-04	804.672	3.57632	1.8288		1.11E+02	4.02E-05	3.27E-10	1.11E-07	2.93E-06	3.34E-06	3.99E-03	6.07E-03	5.50E-10	5.20E-06
2.9	6.37E-05	804.672	3.57632	1.8288		6.13E+01	2.21E-05	1.80E-10	6.13E-08	2.93E-06	3.34E-06	3.99E-03	6.07E-03	5.50E-10	5.20E-06
3.6	1.06E-04	804.672	3.57632	1.8288		9.35E+01	3.37E-05	2.74E-10	9.35E-08	2.93E-06	3.34E-06	3.99E-03	6.07E-03	5.50E-10	5.20E-06
3.9	6.38E-05	804.672	3.57632	1.8288		6.43E+01	2.32E-05	1.89E-10	6.43E-08	2.93E-06	3.34E-06	3.99E-03	6.07E-03	5.50E-10	5.20E-06
4.4	3.55E-05	804.672	3.57632	1.8288		3.65E+01	1.32E-05	1.07E-10	3.65E-08	2.93E-06	3.34E-06	3.99E-03	6.07E-03	5.50E-10	5.20E-06
5.5	3.92E-05	804.672	3.57632	1.8288		3.87E+01	1.40E-05	1.13E-10	3.87E-08	2.93E-06	3.34E-06	3.99E-03	6.07E-03	5.50E-10	5.20E-06
6.1	3.75E-05	804.672	3.57632	1.8288		3.88E+01	1.40E-05	1.14E-10	3.88E-08	2.93E-06	3.34E-06	3.99E-03	6.07E-03	5.50E-10	5.20E-06
6.3	6.05E-05	804.672	3.57632	1.8288		6.03E+01	2.18E-05	1.77E-10	6.03E-08	2.93E-06	3.34E-06	3.99E-03	6.07E-03	5.50E-10	5.20E-06
6.7	2.71E-04	804.672	3.57632	1.8288		2.39E+02	8.64E-05	7.02E-10	2.39E-07	2.93E-06	3.34E-06	3.99E-03	6.07E-03	5.50E-10	5.20E-06
6.9	1.26E-04	804.672	3.57632	1.8288		1.25E+02	4.51E-05	3.66E-10	1.25E-07	2.93E-06	3.34E-06	3.99E-03	6.07E-03	5.50E-10	5.20E-06
7	4.06E-05	804.672	3.57632	1.8288		4.07E+01	1.47E-05	1.19E-10	4.07E-08	2.93E-06	3.34E-06	3.99E-03	6.07E-03	5.50E-10	5.20E-06
7.2	9.77E-05	804.672	3.57632	1.8288		1.30E+02	4.70E-05	3.82E-10	1.30E-07	2.93E-06	3.34E-06	3.99E-03	6.07E-03	5.50E-10	5.20E-06
7.5	3.24E-05	804.672	3.57632	1.8288		3.18E+01	1.15E-05	9.33E-11	3.18E-08	2.93E-06	3.34E-06	3.99E-03	6.07E-03	5.50E-10	5.20E-06
8.3	1.18E-04	804.672	3.57632	1.8288		1.08E+02	3.91E-05	3.18E-10	1.08E-07	2.93E-06	3.34E-06	3.99E-03	6.07E-03	5.50E-10	5.20E-06
8.5	7.26E-05	804.672	3.57632	1.8288		6.99E+01	2.52E-05	2.05E-10	6.99E-08	2.93E-06	3.34E-06	3.99E-03	6.07E-03	5.50E-10	5.20E-06
8.6	3.87E-05	804.672	3.57632	1.8288		3.43E+01	1.24E-05	1.01E-10	3.43E-08	2.93E-06	3.34E-06	3.99E-03	6.07E-03	5.50E-10	5.20E-06
9.6	3.94E-05	804.672	3.57632	1.8288		3.35E+01	1.21E-05	9.83E-11	3.35E-08	2.93E-06	3.34E-06	3.99E-03	6.07E-03	5.50E-10	5.20E-06
9.9	2.16E-05	804.672	3.57632	1.8288		2.19E+01	7.89E-06	6.42E-11	2.19E-08	2.93E-06	3.34E-06	3.99E-03	6.07E-03	5.50E-10	5.20E-06
10.9	1.93E-05	804.672	3.57632	1.8288		2.03E+01	7.32E-06	5.95E-11	2.03E-08	2.93E-06	3.34E-06	3.99E-03	6.07E-03	5.50E-10	5.20E-06
11 (All)	3.33E-05	804.672	3.57632	1.8288		3.30E+01	1.19E-05	9.68E-11	3.30E-08	2.93E-06	3.34E-06	3.99E-03	6.07E-03	5.50E-10	5.20E-06
11 (W023W)	3.07E-05	804.672	3.57632	1.8288		3.12E+01	1.13E-05	9.16E-11	3.12E-08	2.93E-06	3.34E-06	3.99E-03	6.07E-03	5.50E-10	5.20E-06
11 (W023)	2.85E-05	804.672	3.57632	1.8288		2.88E+01	1.04E-05	8.45E-11	2.88E-08	2.93E-06	3.34E-06	3.99E-03	6.07E-03	5.50E-10	5.20E-06
11 (W023E)	4.23E-05	804.672	3.57632	1.8288		4.04E+01	1.46E-05	1.18E-10	4.04E-08	2.93E-06	3.34E-06	3.99E-03	6.07E-03	5.50E-10	5.20E-06
Sitewide	1.34E-03	14484.1	3.57632	1.8288		7.54E+01	4.68E-04	2.11E-10	7.54E-08	2.80E-06	3.34E-06	2.89E-03	6.07E-03	5.50E-10	5.20E-06

Residential Criteria ($\mu\text{g}/\text{m}^3$)

4.90E-03

Industrial Criteria ($\mu\text{g}/\text{m}^3$)

2.10E-02

Formulas

$$C_{aFE} = (q_{FE} \times L) / (u \times H)$$

$$q = K_{overall} \times [1000C - (C_a/K_H)]$$

$$K_{overall} = 1 / [(1/K_c) + (1/(K_G \times K_H))]$$

$$K_L = (6.5E-06) \times [D_w / (1.488E-09)]^{0.67}$$

$$K_G = K_{G, H2O} \times [D_a / (2.6E-05)]^{0.67}$$

$$C_a/K_H \approx 0$$

$\mu\text{g}/\text{m}^3$ = micrograms per cubic meter

m = meter

m/s = meters per second

pg/L = picograms per liter

mg/L = milligrams per liter

mg/ $\text{m}^2\cdot\text{s}$ = milligrams per square meter-second

m^2/s = square meters per second

Table 3 Modeled PCB Concentration in Air (Box Model)

River Mile	Sum of C_{aFE} for all Homologs	River Mile Length L	Wind Speed u	Height H	Trichlorobiphenyl homologs	Conc. in Air C_{aFE}	Flux of Contaminant from Flat Surface q_{FE}	Conc. in Water converted C_w	Overall Mass Transfer Coefficient $K_{overall}$	Mass Transfer Coefficient for liquid K_L	Mass Transfer Coefficient for gas K_G	Henry's Law Constant K_H	Diffusivity in Water D_w	Diffusivity in Air D_a
	($\mu\text{g}/\text{m}^3$)	(m)	(m/s)	(m)		($\mu\text{g}/\text{m}^3$)	($\text{mg}/\text{m}^2\cdot\text{s}$)	(mg/L)	(m/s)	(m/s)	(m/s)	(unitless)	(m^2/s)	(m^2/s)
2 (All)	8.20E-05	804.672	3.57632	1.8288	8.30E+01	3.18E-05	2.58E-10	8.30E-08	3.11E-06	3.46E-06	4.10E-03	7.58E-03	5.80E-10	5.40E-06
2 (W025W)	5.90E-05	804.672	3.57632	1.8288	4.87E+01	1.86E-05	1.52E-10	4.87E-08	3.11E-06	3.46E-06	4.10E-03	7.58E-03	5.80E-10	5.40E-06
2 (W025M)	5.29E-05	804.672	3.57632	1.8288	4.61E+01	1.77E-05	1.44E-10	4.61E-08	3.11E-06	3.46E-06	4.10E-03	7.58E-03	5.80E-10	5.40E-06
2 (W025E)	1.44E-04	804.672	3.57632	1.8288	1.66E+02	6.37E-05	5.17E-10	1.66E-07	3.11E-06	3.46E-06	4.10E-03	7.58E-03	5.80E-10	5.40E-06
2.1	1.17E-04	804.672	3.57632	1.8288	1.44E+02	5.52E-05	4.49E-10	1.44E-07	3.11E-06	3.46E-06	4.10E-03	7.58E-03	5.80E-10	5.40E-06
2.9	6.37E-05	804.672	3.57632	1.8288	5.65E+01	2.16E-05	1.76E-10	5.65E-08	3.11E-06	3.46E-06	4.10E-03	7.58E-03	5.80E-10	5.40E-06
3.6	1.06E-04	804.672	3.57632	1.8288	1.24E+02	4.76E-05	3.87E-10	1.24E-07	3.11E-06	3.46E-06	4.10E-03	7.58E-03	5.80E-10	5.40E-06
3.9	6.38E-05	804.672	3.57632	1.8288	5.59E+01	2.14E-05	1.74E-10	5.59E-08	3.11E-06	3.46E-06	4.10E-03	7.58E-03	5.80E-10	5.40E-06
4.4	3.55E-05	804.672	3.57632	1.8288	2.79E+01	1.07E-05	8.69E-11	2.79E-08	3.11E-06	3.46E-06	4.10E-03	7.58E-03	5.80E-10	5.40E-06
5.5	3.92E-05	804.672	3.57632	1.8288	2.97E+01	1.14E-05	9.25E-11	2.97E-08	3.11E-06	3.46E-06	4.10E-03	7.58E-03	5.80E-10	5.40E-06
6.1	3.75E-05	804.672	3.57632	1.8288	2.89E+01	1.11E-05	8.99E-11	2.89E-08	3.11E-06	3.46E-06	4.10E-03	7.58E-03	5.80E-10	5.40E-06
6.3	6.05E-05	804.672	3.57632	1.8288	4.72E+01	1.81E-05	1.47E-10	4.72E-08	3.11E-06	3.46E-06	4.10E-03	7.58E-03	5.80E-10	5.40E-06
6.7	2.71E-04	804.672	3.57632	1.8288	2.51E+02	9.62E-05	7.82E-10	2.51E-07	3.11E-06	3.46E-06	4.10E-03	7.58E-03	5.80E-10	5.40E-06
6.9	1.26E-04	804.672	3.57632	1.8288	1.40E+02	5.36E-05	4.35E-10	1.40E-07	3.11E-06	3.46E-06	4.10E-03	7.58E-03	5.80E-10	5.40E-06
7	4.06E-05	804.672	3.57632	1.8288	3.20E+01	1.23E-05	9.96E-11	3.20E-08	3.11E-06	3.46E-06	4.10E-03	7.58E-03	5.80E-10	5.40E-06
7.2	9.77E-05	804.672	3.57632	1.8288	6.91E+01	2.64E-05	2.15E-10	6.91E-08	3.11E-06	3.46E-06	4.10E-03	7.58E-03	5.80E-10	5.40E-06
7.5	3.24E-05	804.672	3.57632	1.8288	2.45E+01	9.39E-06	7.63E-11	2.45E-08	3.11E-06	3.46E-06	4.10E-03	7.58E-03	5.80E-10	5.40E-06
8.3	1.18E-04	804.672	3.57632	1.8288	4.43E+01	1.69E-05	1.38E-10	4.43E-08	3.11E-06	3.46E-06	4.10E-03	7.58E-03	5.80E-10	5.40E-06
8.5	7.26E-05	804.672	3.57632	1.8288	2.90E+01	1.11E-05	9.01E-11	2.90E-08	3.11E-06	3.46E-06	4.10E-03	7.58E-03	5.80E-10	5.40E-06
8.6	3.87E-05	804.672	3.57632	1.8288	2.98E+01	1.14E-05	9.26E-11	2.98E-08	3.11E-06	3.46E-06	4.10E-03	7.58E-03	5.80E-10	5.40E-06
9.6	3.94E-05	804.672	3.57632	1.8288	2.89E+01	1.11E-05	8.99E-11	2.89E-08	3.11E-06	3.46E-06	4.10E-03	7.58E-03	5.80E-10	5.40E-06
9.9	2.16E-05	804.672	3.57632	1.8288	1.58E+01	6.06E-06	4.92E-11	1.58E-08	3.11E-06	3.46E-06	4.10E-03	7.58E-03	5.80E-10	5.40E-06
10.9	1.93E-05	804.672	3.57632	1.8288	1.19E+01	4.55E-06	3.69E-11	1.19E-08	3.11E-06	3.46E-06	4.10E-03	7.58E-03	5.80E-10	5.40E-06
11 (All)	3.33E-05	804.672	3.57632	1.8288	2.56E+01	9.80E-06	7.96E-11	2.56E-08	3.11E-06	3.46E-06	4.10E-03	7.58E-03	5.80E-10	5.40E-06
11 (W023W)	3.07E-05	804.672	3.57632	1.8288	2.14E+01	8.19E-06	6.66E-11	2.14E-08	3.11E-06	3.46E-06	4.10E-03	7.58E-03	5.80E-10	5.40E-06
11 (W023)	2.85E-05	804.672	3.57632	1.8288	2.02E+01	7.71E-06	6.27E-11	2.02E-08	3.11E-06	3.46E-06	4.10E-03	7.58E-03	5.80E-10	5.40E-06
11 (W023E)	4.23E-05	804.672	3.57632	1.8288	3.71E+01	1.42E-05	1.15E-10	3.71E-08	3.11E-06	3.46E-06	4.10E-03	7.58E-03	5.80E-10	5.40E-06
Sitewide	1.34E-03	14484.1	3.57632	1.8288	6.89E+01	4.57E-04	2.06E-10	6.89E-08	3.00E-06	3.46E-06	2.97E-03	7.58E-03	5.80E-10	5.40E-06

Residential Criteria ($\mu\text{g}/\text{m}^3$)

4.90E-03

Industrial Criteria ($\mu\text{g}/\text{m}^3$)

2.10E-02

Formulas

$$C_{aFE} = (q_{FE} \times L) / (u \times H)$$

$$q = K_{overall} \times [1000C - (C_a/K_H)]$$

$$K_{overall} = 1 / [(1/K_L) + (1/(K_G \times K_H))]$$

$$K_L = (6.5E-06) \times [D_w / (1.488E-09)]^{0.67}$$

$$K_G = K_{G,H2O} \times [D_a / (2.6E-05)]^{0.67}$$

$$C_a/K_H \approx 0$$

$\mu\text{g}/\text{m}^3$ = micrograms per cubic meter

m = meter

m/s = meters per second

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mg/m²s = milligrams per square meter-second

m²/s = square meters per second